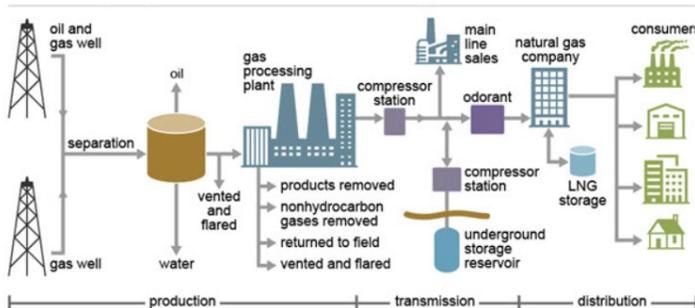




The U.S. Department of Energy Fossil Energy's Natural Gas Technologies (NGT) R&D aims to strengthen natural gas pipeline reliability and ensure infrastructure resiliency; and research advanced materials and sensor technology to address natural gas infrastructure health, public safety, and operational efficiency.

Effective methane emissions mitigation strategies are dependent upon accurate emissions estimations from intentional and fugitive sources within natural gas infrastructure and components. Emissions continually change as rates of upstream development increase or decrease, operators adopt new technologies and mitigation strategies, and regulatory actions are implemented. Therefore, there is a continual need to maintain a state-of-the-industry understanding of operational performance across the different natural gas production and delivery regions within the United States in order to maximize the value to the public.



Natural gas production and delivery system.

Quick Facts

Natural gas is a naturally occurring hydrocarbon gas mixture that is formed deep beneath the Earth's surface within sedimentary basins. It contains many different organic compounds, the largest percentage of which is methane. Natural gas may also contain natural gas liquids (NGLs) and nonhydrocarbon gases (ex. CO₂, H₂S, etc.) and water.

When produced from the subsurface, natural gas is piped from the wellhead to processing plants where water vapor and nonhydrocarbon compounds are removed, and NGLs are isolated and sold separately. Some wellhead natural gas is dry (pure methane) enough to satisfy pipeline transportation standards without processing.

Further downstream within the natural gas supply chain, chemical odorants are added to natural gas so that leaks in natural gas pipelines can be detected. Dry natural gas is sent through pipelines to underground storage fields or to distribution companies and then to consumers or end users. In places where natural gas pipelines are not available the natural gas may be reinjected into the oil-bearing formation, vented, or burned (flared). Reinjecting unmarketable natural gas can help to maintain pressure in oil wells to improve oil production.

Program Components & Successes

Natural gas is a critical fuel source for the U.S. economy. Pipelines are the primary mode of transportation for delivering natural gas to the domestic market and requires an extended and interconnected network of pipelines comprising more than 1.3 million miles of distribution mains, nearly 300 thousand miles of transmission pipelines, and almost 12 thousand miles of gathering lines. A leak or rupture in the transmission pipeline system can release methane and cause a significant disruption in transmission service. As the system expands and increases in complexity, natural gas infrastructure must continue to efficiently and cost-effectively support the production and delivery without impacting safety, reliability, and security.

To address the challenge of expanding delivery and transport infrastructure, investments by the DOE's FE and the Natural Gas Technologies (NGT) R&D program aim to enhance natural gas pipeline reliability and ensure infrastructure security by (1) quantifying emissions to contextualize mitigation technology development and (2) focusing on early-stage research on advanced materials and sensor technology to address the reliability, public safety, operational efficiency, and flexibility of the Nation's aging natural gas infrastructure. By modernizing U.S. energy systems technologies in a changing global marketplace and supporting fuels diversity through research, demonstration, and analysis, FE's Division of Supply & Delivery and its partners can develop reliable natural gas technologies that provide energy security benefits, while reducing environmental footprints.

Research on Natural Gas Technologies includes sensor technologies and advanced pipeline materials, which undergo after-laboratory validation through field testing and demonstration. Research emphasis is primarily focused on the portion of the system that connects producing fields with local distribution systems, broadly defined here as “midstream.”

The NGT R&D program is creating revolutionary advances in material science and integration processes enabling:

- New and more robust generation of “smart” pipeline materials for longer-life and more resilient gathering, compression, transportation and storage system components.
- Sensor platforms (both conventional and embedded inside the pipe) that are capable of “real-time” identification and quantification of methane emissions.
- Timely inside the pipe pipeline system inspection and repair without further damage to assets or disruption of service.

Improved Resiliency — Develop novel coatings and pipeline materials to extend the operational life of infrastructure and further reduce leakage potential.

Leak Detection and Rate Quantification— Develop novel sensor platforms for “real-time” detection of leakage from pipelines, gathering systems, underground natural gas storage facilities and other midstream infrastructure.

Leak Mitigation and Repair — Research materials and tools to mitigate leakage from pipelines and associated components with minimal disruption of service.

NGT R&D will ensure the safe, efficient transport of natural gas resources by:

- Developing new materials, technologies, and processes that improve the reliability, resiliency, and security of pipelines and pipeline components delivering natural gas to end users.
- Reducing methane emissions to the atmosphere from midstream infrastructure.
- Minimizing stranded gas in pipeline infrastructure to ensure that full value of the resource is received by

end users and full economic value is realized by stakeholders.

- Improving natural gas delivery in the U.S. with technologies that enhance the integrity, reliability, performance and economics of the nation’s fossil fuel infrastructure by supplying novel materials and intelligent tools capable of automatic monitoring, control, and optimization.

Major Accomplishments

The Division of Supply & Delivery programs have had several important accomplishments in collaboration with its partners.

The Smart Methane Emission Detection System (SLED/M):

Conventional detection systems, designed to locate larger leaks, suffer from false positives and missed detections, which hamper effectiveness and utilization by industry. SwRI developed a system to reliably and accurately identify methane leaks at critical midstream sections of the natural gas distribution network in real time for the purpose of mitigating methane emissions. The SLED/M system successfully detected methane leaks from a Mid-Wave Infrared camera stream in real-time.

National Petroleum Council (NPC) Dynamic Delivery Study:

The NPC Dynamic Delivery Study articulated the challenges of delivering oil and natural gas via existing transportation infrastructure. DOE leveraged the NPC Study recommendations to develop a Strategic Roadmap to chart a path forward for program priorities and R&D activities, including: steps to ensure sufficient natural gas transportation infrastructure is in place, especially in growth basins; and supporting R&D on pipeline inspection technologies, to include developing an artificial intelligence (AI) physics-informed, data-driven, machine learning (ML) pipeline diagnostic analytics software tool, as well as new pipeline and repair coating systems.

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